

4.5 Software Design and Verification Assurance Processes

4.5.1 Guidelines and Plans

Boeing software quality assurance (SQA) affects every aspect of the X-37 development effort. SQA covers activities conducted in-house at Seal Beach, at the IWA partners, and at external software suppliers. Software quality "how's" are documented in Boeing and X-37 project standards and guidelines. These include:

- General guideline documents (GV specifications) and Software Process Manual (SPM)
- X-37 planning documents
- Software Product Plan (SPP)
- Software Standard and Procedure Manual (SSPM)
 - coding standards
- Software Process Design Document (SPDD)
- Software Development Plan (SDP)
- Software Quality Plan
- Configuration Management Plan
- Risk Management Plan

As indicated above, the Software Development Plan is the key document that defines the overall software quality assurance role for the project. This includes a description of the technical interchange meetings (TIM), reviews, and audits to be conducted. In addition, to providing details of the configuration management, risk management, and software supplier oversight processes, it also addresses software corrective actions and IV&V process and liaison activities.

4.5.2 Design and Development

The general software development process is depicted in figure 4.11.

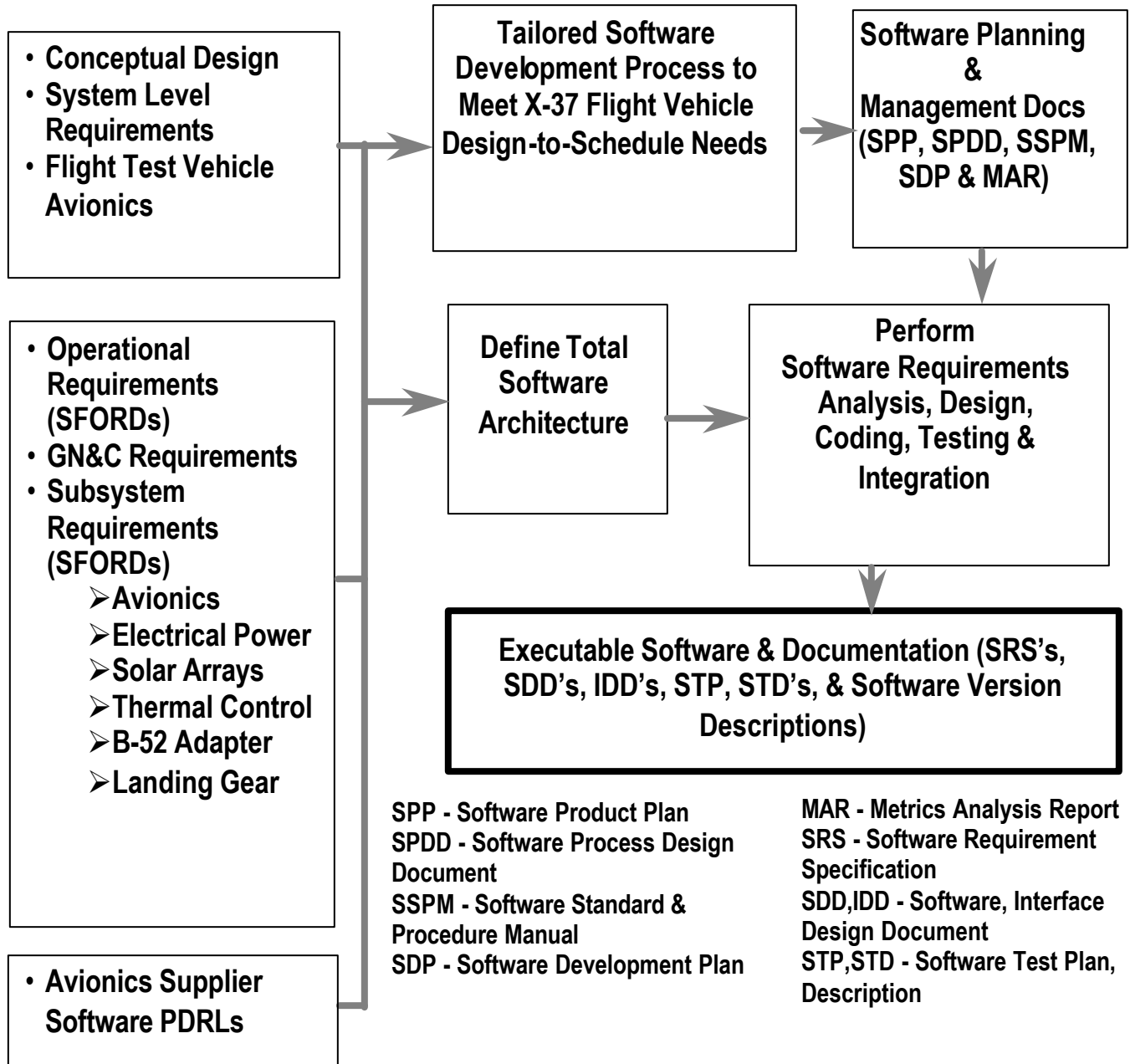


Figure 4.11 Software Design and Development Process

This process describes the top-level requirements analysis/flow down process and subsequent design activities which begin with system/subsystem level and operational requirements and result in executable software and documents. Figure 4.12 provides details concerning the flight software development steps including where static, real time, and hardware-in-the-loop integrated testing typically occur in the developmental process.

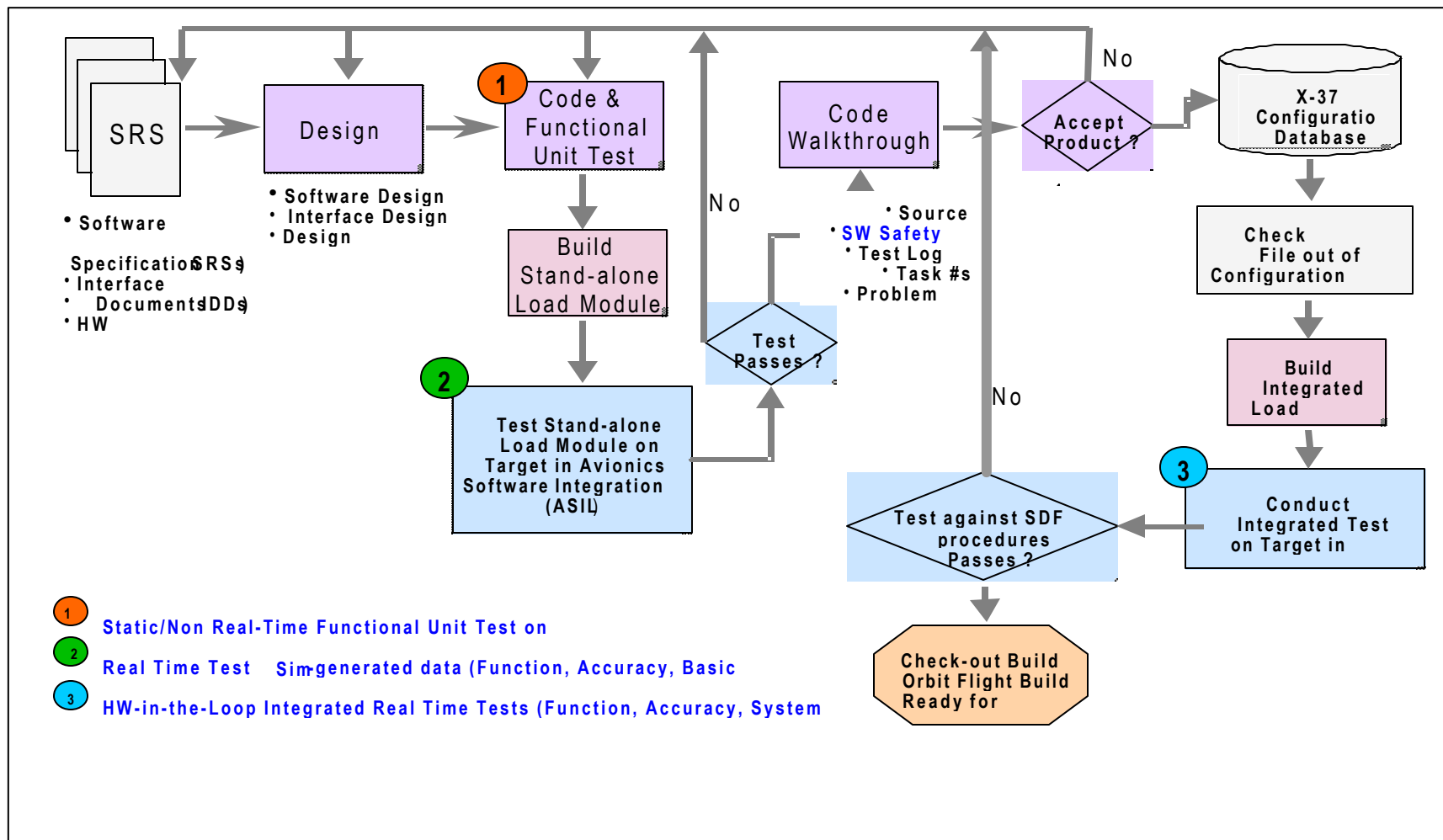


Figure 4.12 Flight Software Development Steps

4.5.3 X-37 Software Products

Figure 4.13 identifies the current mission critical and support software deliverables for the X-37 project. This chart also identifies software products with respect to in-house or subcontractor development responsibilities.

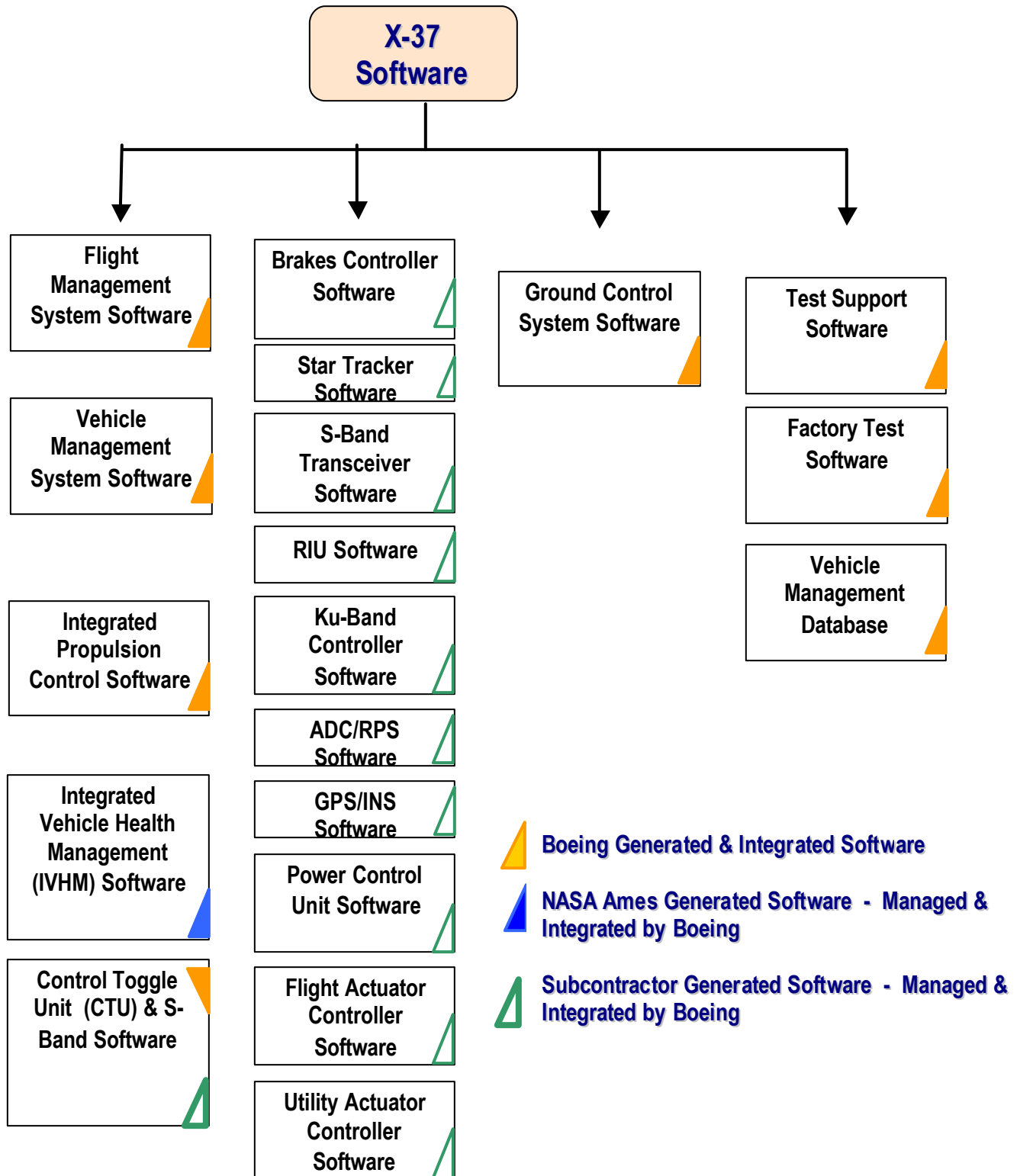


Figure 4.13 Software Deliverables

It should be noted that while Boeing is rated at Software Engineering Institute Capability Maturity Model (SEI/CMM) Level 5, the X-37 software development activity is following SEI/CMM Level 4.

4.5.4 Software Supplier Oversight

Oversight of software suppliers and subcontractors is governed by Boeing general guideline documents (referenced in paragraph 4.5.1) which specifically address selecting subcontractors, planning work packages, and monitoring software quality assurance and configuration management activities. Typically, a software engineer (subcontractor software oversight manager) is assigned to oversee suppliers and products. His tasks generally include:

- Interfacing with NASA (including IV&V), Boeing contract, management and leads, SQA, and configuration management
- Maintains software suppliers (internal and external), products, and contents lists
- Utilizes software suppliers tracker tool to monitor each product
- Identifies nonconformances and tracks to closure
- Communicates progress/issues/risks to supplier, Boeing management, and NASA

The software engineer or oversight manager also reviews and approves supplier documentation for technical content and attends supplier reviews as appropriate.

4.5.5 IV&V Liaison and Support

Boeing will maintain active liaison between the X-37 project software development activities and AVERSTAR/NASA IV&V teams. The principal objective of this liaison and support function will be to verify systems and operational requirements compliance, feasibility, testability, and traceability and to work with NASA on process recommendations and nonconformance issues. The planned scope of this effort will include all flight critical software as defined by the IV&V facility's criticality and risk assessment (CARA) process. Boeing will also be responsible for monitoring IWA and outside supplier software processes, products, and development efforts.

4.5.6 Software Test Strategy

Boeing has adopted a flight software test approach that involves parallel code and test development. Beginning with top-level requirements, the development path includes design, coding, and testing while the parallel verification path provides for test case description and test case implementation. These two paths then converge to produce the validated computer software configuration item (CSCI). Independent verification and validation provides an additional parallel check for this development and test approach. The system test bed build-up begins in the X-37 Avionics and Software Integration Laboratory (ASIL) and culminates in vehicle-in-the-loop testing. At this point formal qualification tested (FQT) software CSCI's are turned over to X-37 vehicle integration. FQT documentation and the software development folders (SDF) serve as the basis for

software vehicle integration test support. To assure continuity, the software engineers responsible for flight, ground control, and factory test software development support the hardware/software vehicle integration activities.